2005 Visual Characterization of Benthic Habitats in the USVI

NOAA/NOS/NCCOS/CCMA Biogeography Program

Benthic habitats in moderately deep waters (>30m and <300m) around the United States Virgin Islands (USVI) were visually-characterized using forward-pointing video and downward-pointing still photography. The data was collected to train and validate an automated benthic habitat characterization technique which uses very fine-scale multibeam data.

Sampling Design

Two independent and distinct sampling designs were chosen to acquire benthic habitat images: one for training and the other for validating the automated habitat characterization technique. Both designs were chosen for their ability to overcome the constraints of cost and time associated with sampling a very large area (~155 square km). A systematic design using non-random transects defined *a priori* was chosen to provide representative training data for the entire study region. This design was chosen to ensure distinct benthic habitat features and transitional areas among features would be adequately represented in the training dataset. A cluster design using a random selection of transects was used to provide the validation dataset. Total sample size was determined based on sampling cost - the number of hours available on the Nancy Foster for ROV data collection.

The training dataset consisted of 17 transects systematically placed over the study area to include as many benthic habitat features and transition zones as possible (Figures 1 and 2). Distinct features and transitional areas were identified by visual examination of fine-scale multibeam bathymetry data collected in 2004 and moderate-scale GEODAS bathymetry data (GEODAS, 2005). The bathymetry data were divided into areas of distinct benthic habitat by variations in depth, roughness and spatial patterning (ridges, bumps, troughs, regular undulations, etc.). To reduce sampling cost, each transect was positioned to include as many distinctive areas as possible and to be parallel to the predominant current and wind direction.

The validation dataset was composed of 21 transects (Figures 1 and 2) chosen from a pool of uniformly-spaced (100 m) parallel transects distributed throughout the sampling extent. The transects were oriented in a NW-SE direction to take advantage of the predominant current and wind direction. The transects originated and terminated at the boundaries defining multibeam acquisition regions. Only transects at least 1km long were considered for logistical reasons.

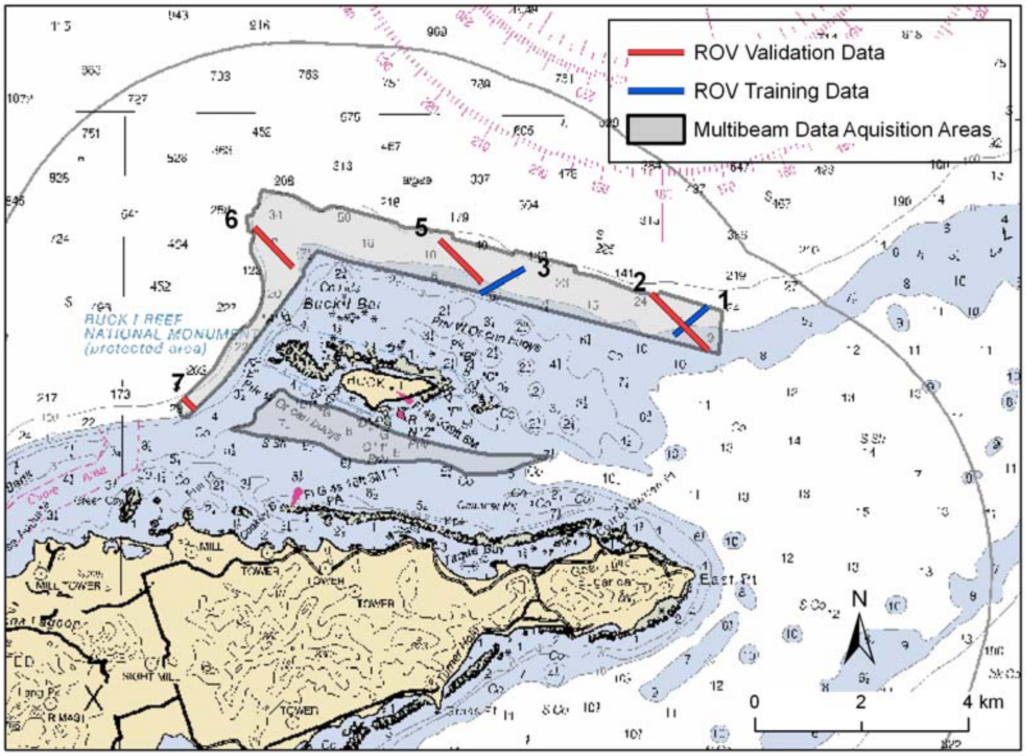

Figure 1: ROV transects completed in 2005 northeast of St Croix, USVI. ROV transects were used to train and validate a habitat characterization model using fine-scale multibeam data. ROV validation and training transects and multibeam data acquisition areas are shown.

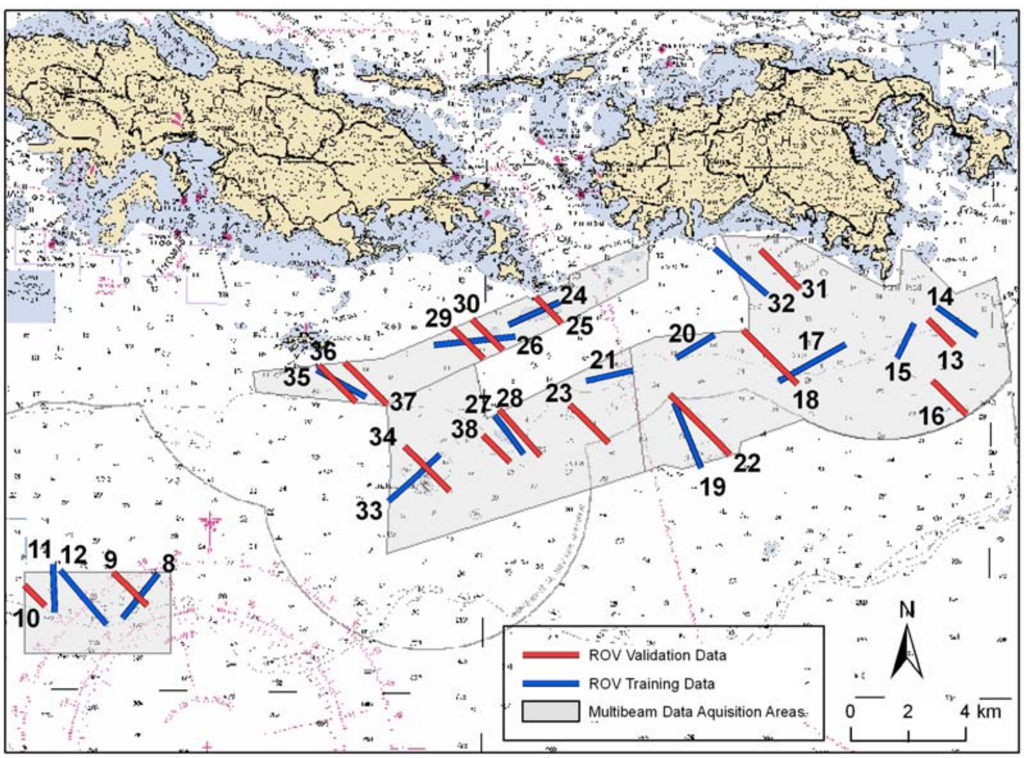

Figure 1: ROV transects completed in 2005 south of St John and St Thomas, USVI. ROV transects were used to train and validate a habitat characterization model using fine-scale multibeam data. ROV validation and training transects and multibeam data acquisition areas are shown.

Video and Photo Acquisition

Image data was taken using a video camera and high-resolution digital still camera mounted on a Spectrum Phantom S2 Remotely Operated Vehicle (ROV) tethered to the NOAA ship Nancy Foster. Two equipment configurations were used to acquire data. When possible the Nancy Foster's twin 300 HP Z-Drives were used to follow the self propelled ROV as it ran a transect. At all other times the ROV was towed by the Foster using a 1 inch steel cable. Both configurations required flawless communication between the bridge and ROV pilots for suitable ROV deployment and collection and maneuvering ships in concert. Data was collected from February 1 to 12, 2005 predominantly during daylight hours to ensure adequate ambient light levels. High powered strobe lights mounted on the ROV were used to supplement ambient light levels during the day and served as the only source of light during the rare night operations. Data from the cameras was transmitted and immediately recorded to a computer's hard drive onboard the Nancy Foster.

Video data was collected throughout the duration of a transect and photo stills were collected at first every 1 min (first 2 transects) and later every 30 secs. Video was collected in digital wmv format and photo stills as jpgs. The forward-facing video camera was pointed at a 45 degree downward angle to give ROV pilots a view of upcoming obstacles and researchers a view of the benthic habitat. The ROV height above the substrate and speed were approximately 2 m and 1 m/s, respectively. The ROV pilot attempted to keep the ROV height and speed as constant as possible to standardize the field of view and spatial resolution of interpretations. Two downward pointing parallel lasers separated by 5 cm and the scale of habitat features and organisms were used to estimate height off the bottom. Still photo images were acquired using a downward pointed camera. The uniform distance between lasers was used in photo interpretations as a scale reference.

A transducer attached to the ROV and an acoustic receiver suspended off the side of the ship were used to determine the ROV's relative position to the ship. The ROVs absolute geographic position was estimated using this relative position and the shipboard GPS. The positional accuracy was estimated to be within 5 m.

Benthic Habitat Interpretation

The benthic habitat was interpreted using a combination of video and photo stills by three interpreters. The benthic habitat was classified by structure, substrate and biological cover.

Structure referred to the broad-scale underlying habitat within the entire field of view. Based on previous benthic habitat work in the area (Kendall et al, 2001 and the 2004 mission) structure was chosen from either 1) colonized pavement, 2) colonized pavement with sand channels, 3) patch reef, 4) spur and groove, 5) scattered coral and rock in sand, or 5) unconsolidated.

Substrate described the visible abiotic components of the benthic habitat. The four substrate classes, considered mutually exclusive and exhaustive, were 1) consolidated material, 2) sand, 3) rubble (particles ~ 2-10 cm) and 4) rhodoliths. Substrate was measured to the nearest percent of the visible bottom. A 10 X 10 grid superimposed on the computer screen was used to help the interpreter estimate coverage. An estimate of rugosity was taken as the vertical range of substrate in the field of view and was classified as either high (> 1 m), moderate (<1 m and >0.3) or low (<0.3 m).

Biological cover referred to the biota visible on top of the substrate and was divided among five mutually-exclusive categories differentiated by their size and shape. Cover was classified into categories for 1) sponge (Phylum Porifera), 2) gorgonian and black coral (Subclass Octocorallia and subclass Ceriantipatharia), 3) hydrocoral and stony coral (Subclass Hexacorallia), and 4) fleshy algae and 5) algae veneer or turf. The sum of all cover categories provided an estimate of total colonization. If a biological cover component could not be unquestionably identified into one of the five cover categories it was only added to the total colonization estimate.

Video was used to interpret structure and substrate rugosity. Still photos were incapable of providing this data because of their relatively small field of view and top-down view, respectively. The still photos were used to estimate the percent cover of finer-scale substrate and biological cover components of the benthic habitat.

Photo stills were viewed in ESRI's ArcMap software (ArcGIS 9) with a superimposed 10 X 10 grid shapefile to aid percent cover estimations. Data was entered into an EXCEL spreadsheet using a custom made VBA script. A snapshot of the software configuration is shown in Figure 3. Video was viewed simultaneously on a second monitor using windows media viewer.

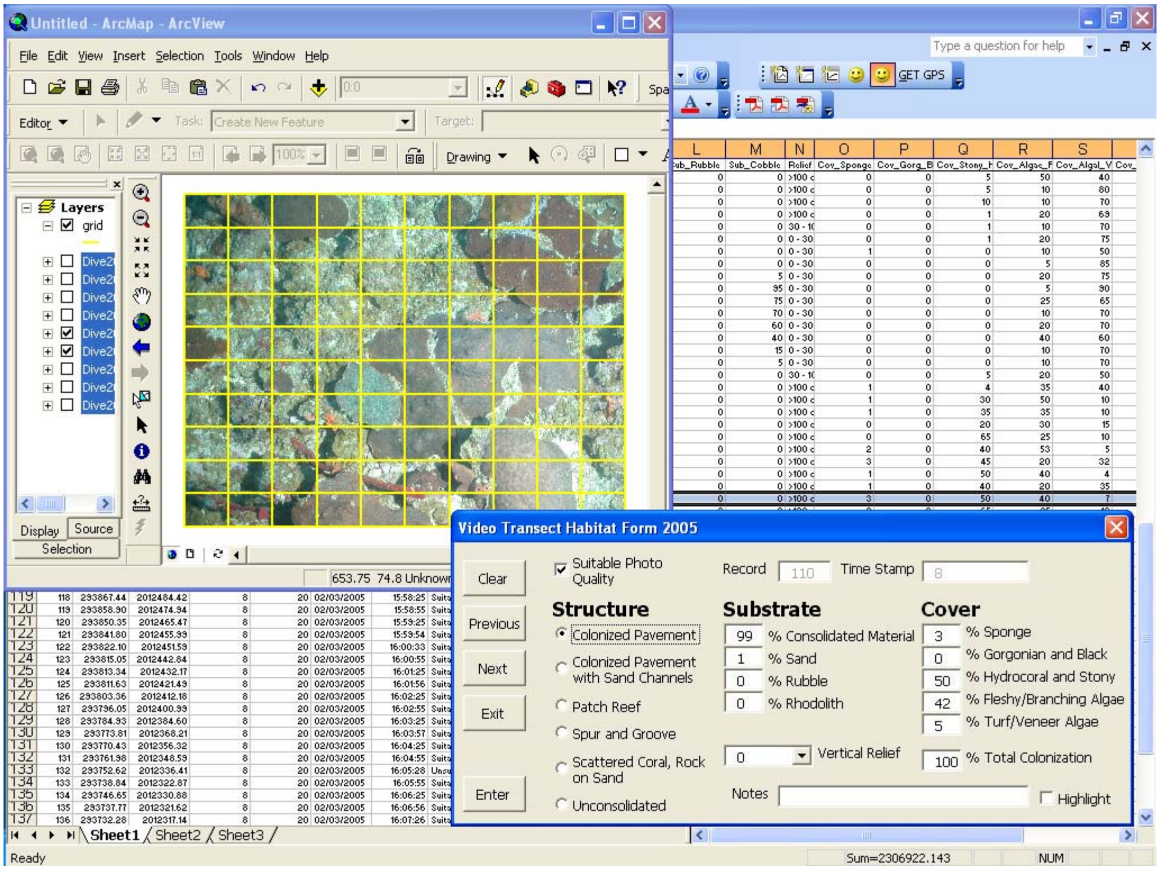

Figure 3: A screenshot of the software configuration and data input form used during interpretations of 2005 still photo interpretations.

Interpretations were standardized among interpreters by repeatedly interpreting the same still photos and video until structure classes were the same and percent covers were within 5% of each other. After the initial standardization, interpreters were assigned random transects to reduce any possible regional bias.

References

GEODAS, 2005. NOAA's GEOphysical DAta System (GEODAS). Website http://www.ngdc.noaa.gov/mgg/geodas/geodas.html, accessed September, 2005.

Kendall, M.S., M.E. Monaco, K.R. Buja, J.D. Christensen, C.R. Kruer, and M. Finkbeiner, R.A. Warner. 2001. (On-line). Methods Used to Map the Benthic Habitats of Puerto Rico and the U.S. Virgin Islands URL: http://biogeo.nos.noaa.gov/projects/mapping/caribbean/startup.htm. Also available on U.S. National Oceanic and Atmospheric Administration. National Ocean Service, National Centers for Coastal Ocean Science Biogeography Program. 2001. (CD-ROM). Benthic Habitats of Puerto Rico and the U.S. Virgin Islands. Silver Spring, MD: National Oceanic and Atmospheric Administration.